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RECENT ADVANCES IN OUR KNOWLEDGE OF THE GENUS *PHYTOPHTHORA*.[*]

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(With Plates II and III).

As usually understood the genus *Phytophthora* comprises a considerable number of species of fungi, all of which are parasitic on living plants, while many of them have been cultivated saprophytically with success.

Several of them are of great economic importance, since the diseases which they cause in cultivated crops often result in very serious losses. In this connection it is sufficient to mention the ordinary potato blight to indicate the extent to which such losses may frequently run.

When de Bary, in 1866, described[1] the details of the development of the conidiophores and conidia of the potato blight fungus, then known as *Peronospora infestans*, Mont., he showed that whereas in species of *Peronospora* such as *P. parasitica*, *P. effusa*, etc., only one conidium is formed at the tip of each branch of the conidiophore, in *Peronospora infestans* two, three, or even many conidia may be developed successively on each branch, their positions being indicated

[*] Read at the Liverpool Meeting of the Association of Economic Biologists, December 31st, 1913. The spelling of many of the specific names is in accordance with the custom of this Journal, for which the Editor, and not the Author, is solely responsible.

[1] de Bary, A. Zur Kenntniss der Peronosporeen. I. Die Conidienbildung von Peronospora infestans. Abhandl. d. Senckenb. naturf. Gesellschaft. Bd. 5, also, Beitr. z. Morph. u. Phys. der Pilze (de Bary and Woronin). Bd. 1, Reihe ii, 1866, p. 35.

by the presence of characteristic swellings on the branches which, up to that time, had not been accounted for satisfactorily.

At the close of this short paper de Bary suggested that on account of this characteristic mode of development of its conidia the potato blight fungus might perhaps form the type of a special genus amongst the Peronosporaceae.

Ten years later, in 1876, he acted on this suggestion,[1] and created the genus *Phytophthora*, *P. infestans* becoming the first member of it.

In 1879 Hartig[2] gave the name *Phytophthora fagi* to the fungus discovered by him in 1875, and then named *Peronospora fagi*, which causes a disease in seedling beech trees; and this species was incorporated by de Bary[3] two years later, together with *Peronospora sempervivi*, Schenk and *Per. cactorum*, Lebert and Cohn in his species *Phytophthora omnivora*.

Recent investigations by Himmelbaur,[4] however, have shown that *Ph. fagi* and *Per. cactorum* must be regarded as distinct species; and this author suggests that de Bary's specific name *omnivora* should be dropped. Presumably on grounds of priority, Schroeter[5] adopted the combination *Phytophthora cactorum* in place of *P. omnivora*, de Bary, and this is the name adopted by Saccardo.[6]

We should thus have *Phytophthora cactorum* (Lebert and Cohn) and *Ph. fagi*, Hartig, as distinct and independent species, the former including as a synonym *Peronospora sempervivi*, Schenk.

With regard to Coleman's *Phytophthora omnivora* var. *Arecae*, I have elsewhere suggested[7] that this species is probably quite distinct from de Bary's *P. omnivora* and deserving of the name *P. arecae*.

Excluding *P. omnivora*, therefore, and including *Per. sempervivi*, Schenk, under *Ph. cactorum*, Schroet., the following is as complete a list of the species of *Phytophthora* described up to the present as I am able to furnish.

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[1] de Bary, A.—Researches into the Nature of the Potato Fungus. Journ. Roy. Agric. Soc. of England, 1876, 12, S.S.

[2] Hartig, R.—Die Buchenkeimkrankheit erzeugt durch *Phytophthora Fagi*. Forstwissenschaft. Centralblatt, 1897, p. 171.

[3] de Bary, A.—Zur Kenntniss der Peronosporeen. Botanische Zeitung, 1881, 39, p. 521.

[4] Himmelbaur, W.—Zur Kenntniss der Phytophthoreen. Jahrb. d. Hamburg. Wiss., Anstalten, 1910, 28, p. 39.

[5] Krypt. Flr. Schles. p. 236.

[6] Saccardo, P.—Sylloge Fungorum, 1888, vol. 7, pars. I, p. 238.

[7] Sci. Proc. Roy. Dublin Soc., 1913, 13. (N.S.), p. 554.

1. ***P. cactorum***, Schroet.[1]
2. ***P. infestans***, de Bary.[2]
3. *P. fagi*, Hartig.[3]
4. *P. phaseoli*, Thaxter.[4]
5. *P. nicotianae*, Breda de Haan.[5]
6. *P. coloeasiae*, Raciborski.[6]
7. *P. thalictri*, Wilson and Davis.[7]
8. *P. agaves*, ? Gandara.[8]
9. *P. syringae*, Klebahn.[9]
10. *P. faberi*, Maublanc.[10]
11. *P. theobromae*, Coleman.[11]
12. *P. omnivora* var. *arecae*, Coleman.[11]
13. *P. erythroseptica*, Pethybridge.[12]
14. *P. parasitica*, Dastur.[13]

In addition to these, cultures of a *P. jatrophae*, Jensen have been sent out by the *Bureau pour la distribution de cultures de moisissures* of the International Association of Botanists in Amsterdam, but I am not aware of the publication as yet of any description of this species, and have been informed by the Bureau that it is probably identical with *P. nicotianae*, de Haan.

In the case of several of the species enumerated in the above list the details of the life-histories are fairly completely known, whereas in regard to others this is not so. It is particularly in regard to the mode of development of the sexual organs of these fungi that our interests are at present concerned.

It is chiefly to de Bary[14, 15] that we owe our knowledge of the development of these organs in those species which have been longest known. In these cases, to take *P. cactorum* as an example, the antheridia and oogonia arise close together usually on short but distinct branches of the same main hypha, and more or less coincidently as to time. Fertilisation takes place by the lateral penetration of the oogonium, which contains an oosphere, by a beak-like outgrowth from the antheridium and by the passage into the oosphere through this beak of a portion of the protoplasmic contents of the antheridium. As a result of fertilisation the oosphere becomes an oospore, around which a thick wall becomes deposited. This method of development of the sexual organs is shared by the members of the genus *Peronospora*.

[1] Cohn's Beiträge z. Biologie, 1875.
[2] Journ. Roy. Agric. Soc. England. 1876.
[3] Forstwiss. Centralblatt, 1879.
[4] Botanical Gazette, 1889.
[5] Med. uit's Lands Plantentuin, 1896.
[6] Parasit. Algen u. Pilze Javas. 1900.
[7] Bull. Torrey Bot. Club, 1907.
[8] Mem. y Rev. Soc. Cient. Ant. Alzate, 1908-9.
[9] Krankheiten des Flieders, 1909.
[10] L'Agric. Pract. d. Pays Chauds, 1909.
[11] Diseases of the Areca Palm, 1910.
[12] Sci. Proc. Roy. Dublin Soc., 1913.
[13] Mem. Dept. Agric. India, Bot. Ser., 1913.
[14] Abhandl. d. Senckenb. naturf. Gesellsch, Bd. 12.
[15] Botanische Zeitung, 1881. Bd. 39.

The sexual organs of some of the species of *Phytophthora* remained for a long time unknown in spite of repeated search for them (this applies particularly to *P. infestans*), and even at present there are some species in which they are either not known at all or only imperfectly known.

The investigations carried on in recent years, however, have added very greatly to our knowledge of the mode of development of these organs, and some rather surprising and highly important results have come to light. These results are in no small degree due to the fact that the fungi in question have been grown successfully as saprophytes in pure cultures on suitable media, and their study has thus been much facilitated.

The starting point of the most recent work was the discovery by Clinton of the long sought for oospores of *Phytophthora infestans*, when the fungus was grown in pure culture on a medium composed chiefly of crushed oats. It is not necessary to go into the history of this matter here, as I have quite recently dealt with it in two papers,[1, 2] in which full references to the literature will also be found.

From these two papers it will be seen that Clinton's discovery has been amply confirmed, and new light has been thrown on the mode of development of the sexual organs in this as well as in some other species of Phytophthora.

P. erythroseptica, Pethyb., which is described in the first of the two papers just referred to, causes a specific disease of the potato plant as a whole, of the "wilt" type, the outward symptoms of which rather closely resemble those of the so-called "Black Stalk Rot" or "Black Leg" disease due to bacteria. From the economic point of view the most serious aspect of the fungus is its capacity for producing a characteristic rot ("Pink Rot") in potato tubers, which, under certain conditions, results in heavy losses.

This fungus can be cultivated with ease as a saprophyte on several media, on which it produces its sexual organs in abundance. By such means it was found possible to follow under the microscope the various phases of the development of these organs from start to finish.

In this species the antheridia and oogonia arise on separate hyphae. At an early stage the young oogonium, or oogonial incept, as I have termed it, penetrates into the interior of the antheridium at or near

[1] Pethybridge, G. H.—On the rotting of potato tubers by a new species of *Phytophthora*, having a method of sexual reproduction hitherto undescribed. Sci. Proc. Roy. Dublin Soc., 1913 13, (N.S.), no. 35.

[2] Pethybridge, G. H., and P. A. Murphy.—On pure cultures of *Phytophthora infestans*, de Bary, and the development of oospores. Ib., 1913, no. 36.

the base, grows up through the latter, and emerges at the summit, when it swells out rather rapidly, forming a spherical portion, in which subsequently an oosphere and then a thick-walled oospore develops.

The ripe sexual organs therefore consist of a pear- or balloon-shaped oogonium, having an oospore in its upper spherical portion, situated above the antheridium, and its conical or funnel-shaped base within and surrounded by the antheridium. The funnel-shaped base is closed off from the hypha bearing the oogonium by a thick plug of cellulose.

Whether an actual process of fertilisation takes place or not is not yet known, but the cytology of the whole series of phases is at present being worked out. If it does it would appear that it must take place while the thin-walled oogonial incept is still within the antheridium, and therefore some considerable time before the formation of the oosphere.[1]

In the case of *P. infestans* the actual phases of development have not directly been observed. This fungus develops its sexual organs much less readily and more irregularly that *P. erythroseptica* does, and further, it only does so satisfactorily on a rather opaque medium. The final state of affairs, however, is identical in the two species, and there is no reason to suppose that there is any important difference in the mode of development of the sexual organs in the two cases. The same holds good also for *P. phaseoli*.

Very soon after the publication of the two papers mentioned further confirmation of the existence of such a novel mode of development of the sexual organs in species of *Phytophthora* was forthcoming from India.

In studying a disease of the Castor Oil Plant, Dastur[2] obtained a new species of *Phytophthora*, which he named *P. parasitica*. His description of the development of the antheridia, oogonia and oospore in this species agrees in all essentials with that described by me for *P. erythroseptica*.

In two respects, however, there are minor differences. In *P. parasitica* it appears that in some cases the antheridium and the oogonium may arise on the same stalk, and when this is so the

[1] Cytological work carried out by my former assistant, Mr. P. A. Murphy, since the above was written and not yet published, shows, however, that this surmise is not correct. The contents of the antheridium and the oogonium follow a normal course of development up to the stage when a uninucleate oosphere is formed. It is extremely probable that fertilisation occurs subsequently, but this point has not been determined as yet with absolute certainty.

[2] Dastur, J. F.—On *Phytophthora parasitica*, nov. spec. A New Disease of the Castor Oil Plant. Mem. Dept. Agric. in India, Botanical Series, 1913, vol. 5, No. 4.

oogonial hypha arises from the base of the antheridium as an outgrowth. This has not been observed in *P. erythroseptica*. In *P. parasitica* the exit of the swollen head of the oogonial hypha (oogonial incept) through the summit of the antheridium is described as taking place by solution of the antheridial wall. In *P. erythroseptica* on the other hand, in the cases where this process was followed under the microscope, the emergence was apparently due to a mechanical bursting of the wall at the summit of the antheridium, and the finely serrated ragged edges of the aperture in the wall through which the oogonium made its exit were clearly visible for some little time afterwards.

In an account of the blight of *Colocasia esculenta*, for which Raciborski had assigned *Phytophthora colocasiae* as a cause in 1900, Butler and Kulkarni[1] provide a description of this parasite based largely on results obtained from pure cultures. The development of the sexual organs in this species is practically identical with that followed in *P. parasitica* and in *P. erythroseptica*. As in the latter species so also in *P. colocasiae* the antheridium and oogonium always arise on separate hyphae. The oogonial origin penetrates the antheridium after indenting its wall, pursues generally a straight course to the opposite wall which it again pierces, to emerge on the further side, where it swells out to form the oogonial cell in which ultimately the oospore develops.

Hence five species of *Phytophthora* have now been described which have this curious intra-antheridial mode of development of the oogonium. These are *P. erythroseptica*, *P. infestans*, *P. phaseoli*, *P. parasitica* and *P. colocasiae*, while, for reasons given in my previous paper, I surmise that Coleman's *P. omnivora* var. *arecae* will be found to resemble these five species in this respect.

In only one of these species, viz., *P. erythroseptica*, has the germination of the oospore as yet been described.[2] In pure cultures of this species the oospore remains within the oogonium to which the antheridium continues to be attached. Germination takes place by the production of a germ tube, which penetrates the oogonium wall and which may soon develop a conidium (zoosporangium) at its apex, or may branch and produce ordinary mycelium.

[1] Butler, E. J., and Kulkarni, G. S.—Studies in Peronosporeacae. Colocasiae Blight caused by *Phytophthora Colocasiae*, Rac. Mem. Dept. Agric. in India, Bot. Series, 1913, vol. 5, No. 5.

[2] Pethybridge, G. H.—Further observations on *Phytophthora erythroseptica*, Pethyb., and on the disease produced by it in the potato plant. Sci. Proc. Roy. Dublin Soc. 1914, vol. 14 (N.S.), No. 10, p. 177.

Before this germ tube arises, however, the thick inner portion of the oospore wall, which consists of a kind of cellulose giving a bright blue colour with the ordinary iodine reagents for cellulose, becomes dissolved, leaving this wall extremely thin in most cases, and thus serves as a supply of reserve carbohydrate food material analagous to that deposited on the walls of the cells of the endosperm of certain seeds and elsewhere.

Butler and Kulkarni suggest, from a study of Hartig's figures of *P. fagi*, that intra-antheridial development of the oogonium may sometimes occur in this species. The same idea had also occurred to me not only with regard to *P. fagi*, but also *P. cactorum* and *P. syringae*.

These three species were therefore cultivated, and the development of the sexual organs and process of fertilisation was followed in the first two of them, but no case of such intra-antheridial growth of the incipient oogonium could be found. In the case of *P. syringae* the phases of development could not actually be followed, as it was only found possible to get the sexual organs to develop in the interior of pieces of sterilised carrot. The final stage of development, however, in this case is similar to that seen in *P. fagi* and *P. cactorum*, namely, an oogonium having an antheridium attached to it laterally by a kind of beak through which fertilisation has occurred.

From what has been said it will be seen that the genus *Phytophthora*, as usually understood, contains species which differ from one another fundamentally in the way in which the development of the sexual organs takes place. On the one hand the oogonium is developed extra-antheridially, and fertilisation occurs after the formation of the oosphere, while on the other hand the development of the oogonium is intra-antheridial, and fertilisation—if it occurs at all, which it probably does—would seem to take place before the formation of the oosphere.[1]

This important difference practically compels the splitting of the old genus *Phytophthora* into two, or at any rate demands the exclusion from it of all the species with one of the above types of oospore formation. The intra-antheridial mode of development of the oogonium was first discovered in *P. erythroseptica*, then in *P. infestans*. Since *P. infestans* was the original type of the genus *Phytophthora*, I have suggested that this generic name should be retained for those species, and those alone, which develop their sexual organs by the intra-antheridial growth of the oogonial incept. The genus *Phytophthora* as thus limited would therefore comprise the five species *erythroseptica*,

[1] See footnote on p. 57.

infestans, phaseoli, colocasiae and *parasitica,* with *arecae* a possible sixth.

Although the development of the sexual organs in the species *sempervivi, cactorum, fagi, syringae* and *theobromae* is similar to that occurring in *Peronospora,* the mode of formation of the conidia differs from that which obtains in this genus, hence it is necessary to place these species and others similar to them in a new genus, for which I have suggested the name *Nozemia.*

With regard to the few remaining species in which the sexual organs are imperfectly known, it remains for further research to decide as to whether they shall be retained in the genus *Phytophthora* or transferred to *Nozemia.*

EXPLANATION OF PLATES II AND III.

Illustrating Dr. G. H. Pethybridge's paper on "Recent Advances in our Knowledge of the Genus *Phytophthora.*"

(The blocks used for the accompanying plates have kindly been lent by the Royal Dublin Society).

PLATE II.

Phytophthora infestans—All figures × 486.

Figs. 1, 2, 3. Abnormalities or deformities seen in mycelium growing submerged in potato-juice sterilized by filtration through a Berkefeld candle. They are probably to be regarded as abortive conidial growths.

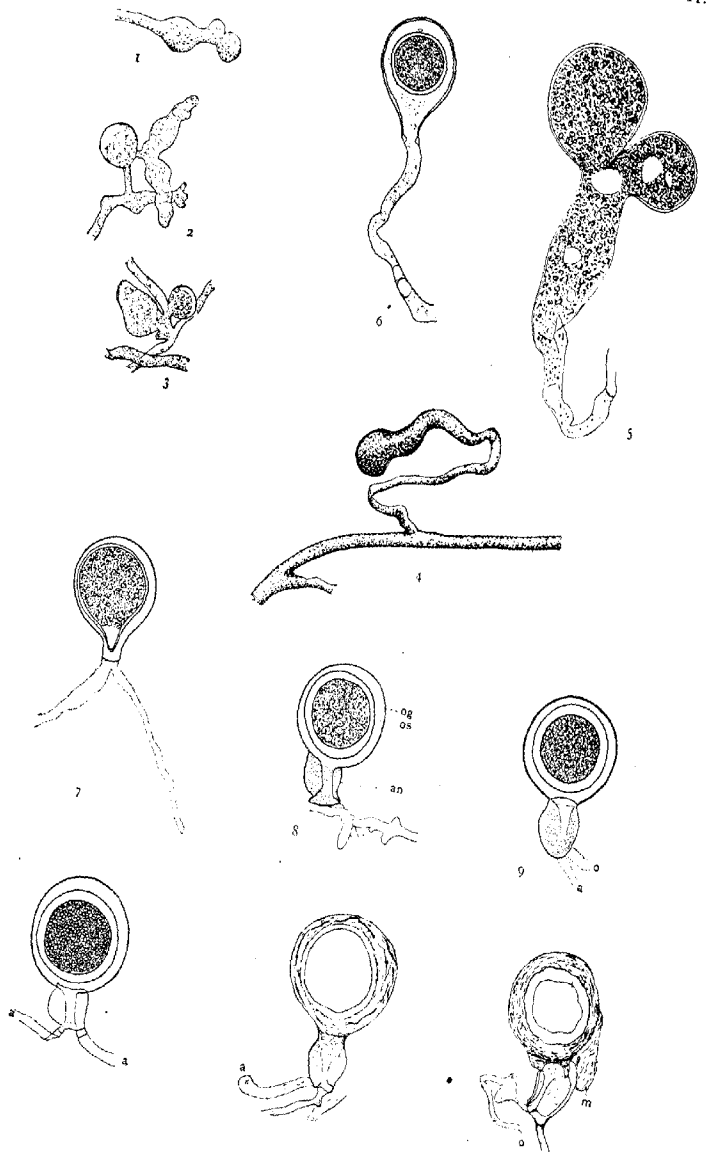
Fig. 4. An early stage in the development of an oogonium, no antheridium is present. (Quaker Oat Agar.)

Fig. 5. A "twin" oogonium in which two oospores would probably have been formed. A distinct wall separating the oogonium from the hypha which bears it is present. (Quaker Oat Agar.)

Fig. 6. An oogonium containing a young, parthenogentically formed oospore. The lower limit of the wall of the oogonium is clearly seen, but there is no septum closing the oogonium from the hypha which bears it. (Quaker Oat Agar.)

Fig. 7. An oogonium borne laterally on a hypha and containing a young pear-shaped oospore, formed parthenogenetically. (Quaker Oat Agar.)

Fig. 8. An oogonium (containing a practically ripe oospore) with its lower portion within an antheridium. The hyphae at the base of the antheridium are probably the oogonial and antheridial hyphae; but it was impossible in the preparation to determine this point with absolute certainty. (Quaker Oat Agar.) *og* = oogonium, *os* = oospore, *an* = antheridium.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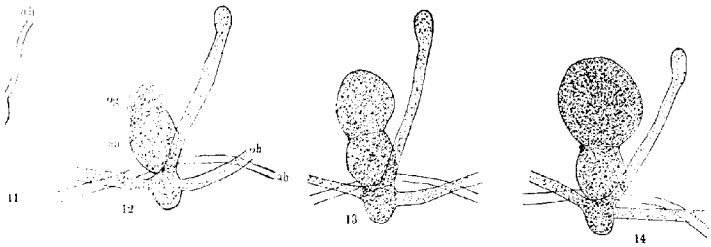
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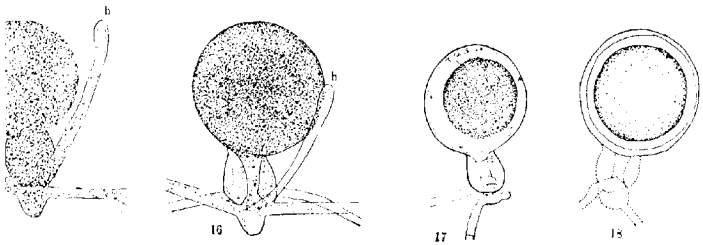
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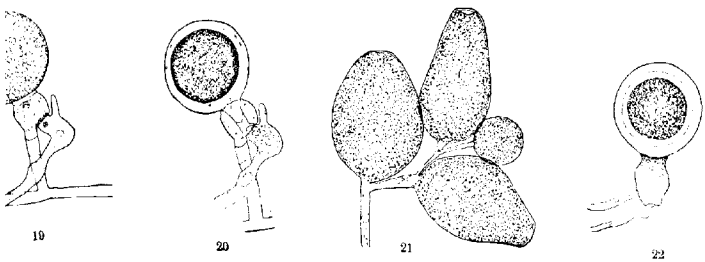
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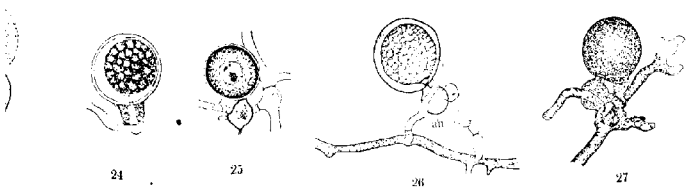
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Fig. 9. An oogonium (with practically ripe oospore) with its antheridium. The antheridium is probably a terminal structure borne on the hypha *a*, the funnel-shaped lower portion of the oogonium within the antheridium is probably continuous with the hypha *o* (at the back); but the connexion could not be made out with certainty. (Quaker Oat Agar.)

Fig. 10. An oogonium (with a practically ripe oospore) with its lower portion within the antheridium, which is a sessile structure on the hypha *aa*. The hypha bearing the oogonium was probably broken off during the removal of the adhering medium. (Quaker Oat Agar.)

Figs 11 and 12. Oogonium, oospore, and antheridium. The irregularities in the oogonium wall are indicated by shading (except over the oospore). In fig. 11 the antheridium is probably a lateral outgrowth of a hypha, the end of which is seen at *a*, the other portion of it being absent. *O* is the hypha which bears the oogonium, and it was definitely traced into the antheridium and seen to be continuous with the funnel-shaped base of the oogonium. In fig. 12 the antheridium is a terminal structure, borne on the hypha *a*; and its contents are represented somewhat contracted away from its walls. *O* is the hypha bearing the oogonium; its passage into the antheridium and continuation as the funnel-shaped base of the oogonium was clearly discernible. *M* is a small portion of adhering medium. (Quaker Oat Agar.)

PLATE III.

Figs. 11 to 21. *P. erythroseptica*.

Fig. 11. An antheridium into which the oogonial incept has penetrated. After treatment with weak caustic soda and staining with Loeffler's methylene blue,—*oh* = oogonial hypha, *ah* = antheridial hypha, *an* = antheridium, *oi* = oogonial incept. × 625.

Fig. 12. Sexual organs drawn about ten minutes after the developing oogonium had burst out through the top of the antheridium. The antheridium *an* is sessile on the now empty antheridial hypha *ah*, the point of origin being at the back, and not shown in the drawing. The oogonial incept is sessile on the oogonial hypha *oh*, which is considerably swollen at the point of origin of the former. The funnel-shaped base of the developing oogonium *og* is only very faintly seen within the antheridium, the broken wall of which at the point of exit is somewhat jagged in outline. At this stage there was rather rapid movement of protoplasm from the oogonial hypha into the developing oogonium. Living material. × 625.

Fig. 13. The same organs as in fig. 12 after the lapse of a period of thirty minutes. The developing oogonium has increased considerably in size. × 625.

Fig. 14. The same after a further period of 2 hours 20 minutes. The broken wall of the antheridium is no longer jagged, but the "beaded" edge is becoming defined. × 625.

Fig. 15. The same after a further period of 2 hours 10 minutes. The oogonium is rapidly attaining its full size, and the contents of the hypha *h* are diminishing in quantity, being drawn upon to fill the oogonium. The funnel-shaped base of the developing oogonium is rather more distinct in this figure than in figs. 12, 13, and 14. × 625.

Fig. 16. The same, 17 hours 20 minutes later than fig. 12. The oogonium has attained its full size, the oogonial hypha has lost most of its contents. Protoplasmic streaming into the oogonium had ceased some time before this. The contents of the antheridium have largely disappeared, revealing clearly the funnel-shaped base of the oogonium within it, the hypha *h* has lost its contents and become reduced in size. × 625.

Fig. 17. Another set of the sexual organs, oosphere stage. Part of the contents of the upper portion of the oogonium have become rounded off, in preparation for the development of the oospore, the remainder forms trabecular structures which subsequently disappear or exists as isolated granules round the periphery. A "plug" in the funnel-shaped base of the oogonium is present. The thickness of the oogonium wall is somewhat exaggerated in this figure. Living material. × 425.

Fig. 18. A ripe oospore within the oogonium. The details of the base of the oogonium, antheridium and hyphae are only approximately indicated. Living material. × 625.

Fig. 19. The sexual organs showing a terminal antheridium and an oogonium derived from a terminal incept. The beaded edge of the broken top of the antheridium is well marked. Living material. × 425.

Fig. 20. The same as fig. 19, two days later, showing an early stage in the formation of the spore. Living material. × 425.

Fig. 21. Conidia showing sympodial development. Drawn after treatment with I in KI. × 625.

Fig. 22. *P. infestans,* showing the funnel-shaped base of the oogonium within the antheridium. The upper part of the funnel is obscured by the presence of portions of the browned oat-agar-medium adhering to the antheridium. These also adhered to some extent to the spherical part of the oogonium but did not obscure it, and have been omitted in the drawing. Living material. × 365.

Fig. 23. Sexual organs of *P. phaseoli* from living material in Lima Bean Agar, showing clearly the course followed by the developing oogonial incept. × 365.

Fig. 24. Sexual organs of Coleman's *P. omnivora* var. *arecae*, from his plate 18, fig. 3. × 335.

Fig. 25. *P. syringae*, Kleb. Sexual organs developed within the tissues of sterile carrot. The base or stalk of the oogonium is *not* within the antheridium. Living material. × 365.

Fig. 26. *P. cactorum*, Schroet. Sexual organs developed in a cover-glass film of carrot extract gelatine. The antheridium *an* is partially overlain by a portion of the hypha bearing the oogonium. The contents of the antheridium at this stage had become very reduced in amount and degenerated, and for the sake of clearness are omitted from the drawing. Living material. × 365.

Fig. 27. Sexual organs of *P. fagi* developing in cover-glass film of carrot extract gelatine, drawn just before fertilization occurs, and showing the lateral penetration of the oogonium by an outgrowth from the antheridium. Living material. × 365.

CLOVER AND LUCERNE LEAF-SPOT.

By IVY MASSEE.

(With 4 Figures).

This disease is far more prevalent and more injurious to clover and lucerne crops in this country than is generally suspected. In the United States it often completely destroys lucerne, or alfalfa, as it is called there, and it is considered as the only important fungus disease attacking this crop. The first symptom of disease to the casual observer is a slight yellowing of the leaves commencing at the base of the plant and gradually creeping upwards. As the disease progresses the leaves assume a decided yellow tinge throughout, commence to wilt, and fall to the ground. When the disease is severe almost complete defoliation takes place, the naked stems alone remaining. Newly-sown clover-fields are frequently ruined by the disease; older stands also suffer to a considerable extent, but are not often killed outright. In the case of lucerne and crimson clover the disease often appears after the first cutting, and succeeding crops are very frequently severely injured.

The fungus causing this disease is called *Pseudopeziza trifolii*. During the period when the host determined the species, different names were given to the various fungi growing on allied leguminous plants. These, however, have been proved by cross-infection experiments to belong in reality to but one species, as named above. There are slight differences in the size of the ascophore, asci and spores, in the various supposed species, but these differences come well within the limits of variation, as observed in any one of the included forms. Furthermore, ascospores from the form growing on clover gave origin to a slightly different form of ascophore, when sown on leaves of lucerne, proving that such variations in form and size are not of specific value, but depend on the texture and mode of venation of the leaf on which they are growing. The fruit of the fungus is formed in the tissue of the leaf, and when approaching maturity bursts through to the surface, under the form of a minute, circular, more or less convex wart of a dark colour, surrounded by the torn epidermis. The fungus is sometimes developed on the stem, sepals, and less frequently on the seed.

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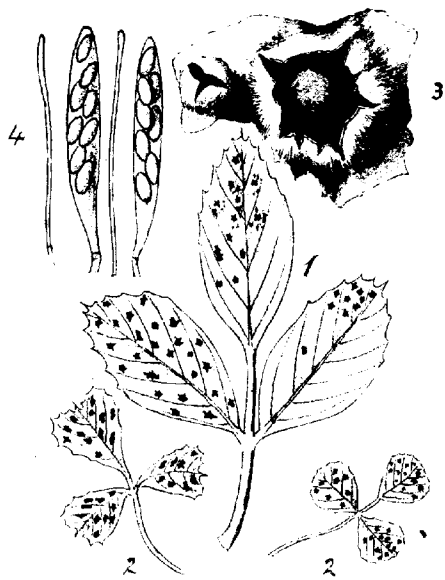
The dissemination of the disease may be effected in various different ways. Where an infected crop has grown, the diseased fallen leaves would prove a source of danger to future crops. In the United States it has been noted that where fields intended for alfalfa have been strewn with soil from another alfalfa field which had been affected with leaf-spot, for the purpose of inoculation with the nodule bacteria, infection often follows, as the result of spores of the fungus having been conveyed along with the soil. The dispersal of the fungus spores by wind is also considered as a factor in spreading the disease;



Pseudopeziza trifolii, Fckl.

Fig. 1. Fungus on lucerne leaf, nat. size.
Fig. 2. Fungus on clover leaves, nat. size.
Fig. 3. Fungus somewhat enlarged.
Fig. 4. Asci and paraphyses. × 400.

but so far as this country is concerned I am inclined to believe that the spread of disease is mainly due to the use of badly cleaned and infected seed. I have recently examined a sample of commercial seed, and found the fungus present in abundance on minute fragments of leaves, on calyces, and rarely on the seed itself.

Synonymy.

The following is the synonymy of *Pseudopeziza trifolii*, given in chronological order:—

Pseudopeziza trifolii, Fckl. (1869.)
Ascobolus trifolii, Bernhardt. (1813.)
Phacidium medicaginis, Desmaz. (1840.)
Peziza dehnii, Rabenh. (1842.)
Phacidium divergens, Roberge. (1864.)
Pyrenopeziza medicaginis, Fckl. (1869.)
Pseudopeziza medicaginis, Sacc. (1893.)

Host-plants.

The fungus has been recorded on the following host-plants:—*Trifolium pratense*, L., *T. repens*, L., *T. medium*, L., *T. arvense*, L., *T. incarnatum*, L., *T. fragiferum*, L., *T. hybridum*, L., *T. pallescens*, Schreb., *T. resupinatum*, L., *Medicago lupulina*, L., *M. sativa*, L., *M. falcata*, L., *M. denticulata*, Willd., *Trigonella faenum-graecum*, L.

Distribution.

This fungus is widely distributed in a state of nature, and probably occurs wherever lucerne and clover are cultivated. Europe, N. and S. America, Australia, New Zealand.

Preventive Measures.

Cleanliness, as usual, is a most important factor in arresting disease, and as the fungus is fairly abundant on many of our wild clovers, also on species of *Medicago*, all such weeds should be kept down in the vicinity of cultivated clover or lucerne.

It should be practicable, without incurring much additional expenditure, to remove all fragments of leaves, etc., from admixture with the seed, thus checking to a great extent the chances of infection. If, on examination, the seed itself is found to be infected, it should be treated by the hydrogen peroxide method I have described in the "Kew Bulletin."

SOME FURTHER OBSERVATIONS ON THE DISPERSAL OF WEED SEEDS BY WILD BIRDS.

By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.

That a certain proportion of the seeds of various weeds which are eaten by wild birds pass through the intestinal canal uninjured and become dispersed in their droppings is now well known, and has been commented upon by Kerner,[1] Darwin,[2] Judd,[3] Beal,[4] Pycraft,[5] myself,[6] and other writers. Kerner (*op. cit.*) has shown that of fruit and seed which passed through the intestinal canal, so much as 75 per cent. germinated in the case of the blackbird, 85 per cent. in the case of the thrush, and 88 per cent. in the case of the rock-thrush. The same writer has also given many interesting details as to the interval of time between ingestion and evacuation, and the effect of ingestion on the seeds.

In a previous paper[6] I have shown that in the case of the house sparrow, bullfinch, and greenfinch large numbers of weed seeds are evacuated, and are capable of germinating and growing into healthy and normal plants.

In analysing and comparing my records for the past three years, viz., 1911, 1912 and 1913, a very interesting fact is brought out, which has an important bearing upon the subject of the distribution of weed seeds by wild birds.

During the dry summer of 1911 (June, July, August and September) the grit and soil content of the gizzard of thirty-six rooks was carefully weighed, the average amount being 108 grains, of which not more than one-sixth was grit. The same number of birds was examined during the wet summer of 1912 (June to September), and the average amount was 214 grains, of which nearly one-third was grit. During 1913 the test was repeated. The climatic conditions were similar to those of 1911, excepting in the early part of June and the

[1] Kerner and Oliver.—Nat. Hist. of Plants, 1895, vol. 2, pp. 862-866.
[2] Darwin, C.—Origin of Species, 6th ed., 1902, p. 510.
[3] Judd, S. D.—U.S. Dept. Agric., Div. Biol. Surv., Bull. No. 17, 1902.
[4] Beal, F. E. L.—*Ibid.*, Bull. No. 30, 1907.
[5] Pycraft, W. P.—A History of Birds, 1910.
[6] Collinge, W. E.—Journ. Bd. Agric., 1913, vol. 20, pp. 15-26.

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latter end of September. For this year the average amount of grit and soil was 129 grains, one-quarter being grit.

Unfortunately, with the rook no experiments could be made with the faeces, but with the house sparrow and starling it has been comparatively easy to show that during the dry summer of 1911 these birds distributed large quantities of weed seeds, but during the wet summer of 1912 they were considerably less, and rather more during that of 1913.

Thus in thirty-eight starlings examined from June to September, 1911, the average soil and grit content was forty-two grains, and the faecal contents, when placed on sterilised soil in the manner I have elsewhere described,[1] resulted in the cultivation of fifty-seven plants referable to six species. A similar number examined during 1912 gave an average soil and grit content of sixty-eight grains, and from the faecal contents only twenty-three plants were cultivated referable to four species. The figures for 1913 were thirty-two plants referable to five species.

Of the house sparrow, during 1911, the soil and grit content was weighed from sixty birds, and averaged twenty-seven and a half grains, from the faecal contents of twenty-four birds fifty-nine plants were cultivated referable to four species. From the same number of specimens examined during 1912, an average soil and grit content of fifty-three grains was obtained, and from the faecal contents of twenty-four of these only eighteen plants were cultivated referable to two species.

From the above observations it would appear that, in dry years, such birds as the rook, starling, house sparrow (and probably many other species) take in a much smaller quantity of grit and soil than in wet years, in consequence of which a larger percentage of weed seeds pass through the intestinal canal in an uninjured condition.

Whilst engaged upon recording these results it occurred to me that it would be interesting and important to endeavour to obtain some corroborative evidence from those actually engaged upon weed investigations as well as from practical farmers, and the following replies to my queries show that there is a very general view amongst the farmers that weeds on arable land are much more in evidence after a dry summer than after a wet one.

A number of farmers were appealed to, and their replies may be summarised as follows:—

1. Twenty per cent. had not observed any difference after a dry or wet summer.

[1] Collinge, W. E.—Journ. Bd. Agric., 1913, vol. 20, pp. 15-26.

2. Sixty-five per cent. were of opinion that there are always more weeds on arable land after a dry summer than after a wet one.

3. Fifteen per cent. were of the same opinion as stated in par. 2, but also added that, from general observations made over a number of years, they were of opinion that the seeds were largely distributed by birds.

A number of investigators on weed problems were written to, but none were able to contribute any evidence to the subject. The matter is one, however, which I believe is worthy of further attention from an economic standpoint, apart from its interest otherwise.

ÜBER DAS VORKOMMEN UND DIE HEIMAT VON *PSEUDISCHNASPIS* (*ASPIDIOTUS*) *BROMELIAE*.

VON DR. LEONHARD LINDINGER.

IN einer kurzen Mitteilung über einige Schildläuse von den Seychellen kommt Green auf die Verbreitung und die noch unbekannte Heimat der genannten Schildlaus zu sprechen.[1] Der Angabe, dass die Laus aus Westindien oder vom amerikanischen Festland noch nicht gemeldet ist, pflichte ich (Station für Pflanzenschutz zu Hamburg, Sonderbruct 26) unumwunden bei, möchte mir aber zu den weiteren Ausführungen Greens einige Bemerkungen gestatten. Green nimmt an, dass die Art nur von englischen Märkten her bekannt sei (Newstead nennt Chester), wo die Laus auf Ananas gefunden wurde, die als von kanarischer Herkunft bezeichnet wurden.[2] Schon im Jahr 1911 habe ich aber in einer Bearbeitung der kanarischen Cocciden[3] darauf hingewiesen, dass die von Newstead gemeldeten Tiere in Wirklichkeit von den Azoren stammen dürften. Seit einer Reihe von Jahren wird nämlich die Art regelmässig auf Ananas von den Azoren, meist von São Miguel, beobachtet.[4] Auch in meinem Schildlausbuch wird die Art von den Azoren angegeben.[5]

Wenn ich nun Green recht verstehe, so neigt er der Meinung zu, *Pseudischnaspis bromeliae* könne afrikanischen Ursprungs sein, soweit wenigstens die Inseln in Betracht kommen; er schreibt nämlich einmal: "The question arises, Is the species indigenous in the Seychelles?" Und etwas später: "Mr. Newstead's evidence points to the Canary Islands. If it should be found to occur on indigenous Bromeliads, in those islands, the presumption would be stronger."

[1] Green.—On some Coccid pests from the Seychelles. Journ. Econ. Biol., 1914, vol. 9, p. 47.

[2] Newstead.—Monograph of the Coccidae of the British Isles. 1903, vol. 1, p. 87.

[3] Lindinger, Afrikanische Schildläuse. IV. Kanarische Cocciden, ein Beitrag zur Fauna der Kanarischen Inseln. Jahrb. Hamb. Wiss. Anst. XXVIII. 3, Beiheft.

[4] Bericht der Station für Pflanzenschutz zu Hamburg: VII, p. 8; VIII, p. 7; X, p. 10. (In neuerer Zeit nicht mehr aufgeführt, weil fast immer vorhanden).

[5] Lindinger, Die Schildläuse (Coccidae) Europas, Nordafrikas und Vorderasiens, einschliesslich der Azoren, der Kanaren und Madeiras, 1912.

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Die strenge Beschränkung auf eine Bromeliacee schliesst eine andere als die amerikanische Herkunft der Laus vollständig aus, denn Bromeliaceen kommen nur in Amerika vor. Auch die Ananas ist amerikanischer Herkunft.

Die Gefahr, dass sich das Insekt zu einem ernsthaften Ananasschädling entwickeln könne, wie Green andeutet, halte ich nicht für gross, denn nach meinen Befunden ist die Entwicklung des Tieres eine vergleichsweise sehr langsame.

Hamburg, den 12 März, 1914.

NOTE ON *ASPIDIOTUS BROMELIAE*.

By E. ERNEST GREEN, F.Z.S., F.E.S.

In my recent paper "On Some Coccid Pests from the Seychelles," I suggested that *Aspidiotus bromeliae* may have its home in the Canary Islands. Dr. Lindinger, writing under date 12th March, disputes this suggestion, and remarks that, so far back as 1911, he had shown that for many years the species has been observed on pineapples imported from the Azores, more particularly from São Miguel. He concludes from this that the insect really originated in the Azores. Dr. Lindinger remarks that, if the species is actually confined to plants of the Order *Bromeliaceae*, its original home should be looked for in America, where these plants (and the pineapple itself) had their origin. So far as it goes, this reasoning may be sound; but our knowledge of the species is still too incomplete to permit of any definite conclusions. We do not even know that it is confined to Bromeliads. And is Dr. Lindinger correct in assigning to America the sole home of the *Bromeliaceae*? I do not profess to any extensive knowledge of Botany, but I was under the impression that India, Ceylon, Java, and some other eastern countries provide many indigenous Bromeliads.

Dr. Lindinger (in contradiction of my further remarks) does not think that the species is at all likely to become a serious pest, as—in his experience—the development of the insect is comparatively slow. I can only reply that the material from the Seychelles showed such a dense infestation that the health of those particular plants must have been seriously affected. The rate of development of any Coccid depends so much upon the presence or absence of natural enemies (*e.g.*, Coccinellid beetles and Hymenopterous parasites) that conclusions based upon its activity in one country may be completely upset by its behaviour in another.

30th March, 1914.

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RECENT PUBLICATIONS ON ECONOMIC ORNITHOLOGY.

By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.

The Feeding Habits of Gulls.[1]—We welcome this report of a sub-committee appointed by the Suffolk and Essex Fishery Board to investigate the feeding habits of Gulls, although it is more in the nature of an interim report. Application is being made to the Board of Agriculture and Fisheries for a grant of £100 towards the continuance of the inquiry, and we trust that it has ere now been granted, for this is a really useful piece of work which the Board might well assist. Writing in 1908[2] a writer stated: "In the matter of economic ornithology we in England are disgracefully behind the times; the Board of Agriculture seemingly prefers to leave this matter to private enterprise, or to deal with the matter in such a perfunctory manner as to be positively ridiculous, making us the laughing-stock of the nations." Since 1908 a considerable amount of private work has been done, so that little remains for the Board to assist; we therefore trust the opportunity that now presents itself will be taken advantage of.

Four hundred and fifty-six birds have been examined, viz., 167 black-headed gulls, 92 common gulls, 86 herring gulls, 13 great black-backed gulls, 10 lesser black-backed gulls, 2 little gulls, 30 kittiwakes, 25 common terns, 4 lesser terns, and 27 divers, including guillimots, razor-bills, red-throated divers, great crested grebe, etc.

So far as the investigation has proceeded it shows that fish of all varieties were present in 28 per cent. of black-headed gulls, 24.5 per cent. of the common gull, and 18.2 of the herring gull. Sixty per cent. of great black-backed gulls contained food fishes, 30 per cent. of lesser black-backed gulls, and 83.5 of kittawakes. Of the remaining species examined the numbers are as yet too small to be of value.

Incidentally it is pointed out that the great black-backed gull, in confinement, digests fish at the rate of 4 oz. per hour, and smaller gulls at a somewhat slower rate. Further experiments are being conducted in order to arrive at the rate of digestion in the former species in its wild state.

[1] Suffolk and Essex Fishery Board. Report of Sub-Committee appointed to make arrangements for and to investigate the Feeding Habits of Gulls during the year 1913. 1914, pp. 15.

[2] Ann. Mag. N. H., 1908 (s. 8), vol. 2, p. 132.

We are somewhat surprised at the small percentage of "land food" (earthworms, insects, etc.) eaten; apart from earthworms it is very small. Cereals were found 2.9, 11.0 and 19.5 per cent. in the black-headed gull, common gull, and herring gull respectively, but it is pointed out that "the black-headed gulls were not examined in the district during the Spring and early Summer, as there are no breeding stations in the immediate vicinity." Common gulls and herring gulls, however, examined from various outside districts, contained a considerable amount of grain. "The destruction of cereals by the herring gull certainly seems a matter for further investigation, when 19.5 per cent., shot mostly at sea, contained cereals."

"The destruction of cereals in Suffolk would appear to be negligible, owing to the fact that no gulls breed in the district, and only a few immature birds are left during the Spring and early Summer, and that in the Autumn, when seed is being sown, there appears to be an abundance of food in the estuaries of our rivers. However, examination of the birds shot on the land might show that they took cereals, for a common gull shot flying over the Orwell on September 26th contained 40 grains of wheat and the gizzard was full of husks, and on December 15th a gull shot at Whitton contained growing Winter wheat."

"Twenty-two nestlings of the black-headed gull were examined. These were obtained from a gullery 150 to 300 yards from high-water mark, and 1½ miles from several small artificial lochs stocked with trout. An analysis of the food contained shows that the material destroyed was distinctly in favour of the agriculturist. There were present, remains of two small fish, 33 useful beetles, and 6 earthworms. On the other hand, 51 harmful beetles and insects and 31 wireworms were destroyed."

This very interesting and valuable report concludes by stating "that it would be manifestly unfair to draw any definite conclusions from it as to the feeding habits of gulls in general. But since gulls have taken to feeding on grain, the balance would appear to be against the gull; and from an economic point of view we consider an exhaustive enquiry is indicated in consequence of the enormous rate at which these birds are increasing throughout the land."

Wild Duck Foods.[1]—The wise foresight of the U.S. Department of Agriculture has seldom been better exemplified than in the present instance, and no more able investigator in economic ornithology could have been allotted the task than Mr. W. L. McAtee.

[1] McAtee, W. L.—Five Important Wild-Duck Foods. U. S. Dept. of Agric., Bull. No. 58, 1914, pp. 1-19, 16 figs.

Some little time ago the Department published a Circular containing information on the value, appearance, distribution, and propagation of three important wild-duck foods, and the information there provided has been widely used by the State game commissions, game protective associations, and individuals interested in the protection, preservation, and propagation of the native species of ducks and geese.

The present Bulletin deals with five other plants of great intrinsic value, viz., the Delta Duck Potato (*Sagittaria platyphylla*), the Wapato (*S. latifolia* and *S. arifolia*), the Chufa (*Cyperus esculentus*), the Wild Millet (*Echinochloa crus-galli*), and the Banana Water Lily (*Nymphaea mexicana*). All of these are described and figured, and particulars given of their distribution and propagation.

THE ECONOMIC STATUS OF THE WESTERN MEADOW-LARK.[1]—In this memoir Mr. H. C. Bryant reviews in great detail his work on the Western Meadow-Lark (*Sturnella neglecta*) in the State of California. It is a very valuable and most interesting piece of work. The investigation has included field investigations, experimentation on the amounts of food consumed and the times of digestion, and stomach examinations of nearly two thousand specimens, obtained from twenty different parts of the State, during each month of the year.

Field investigation shows that this species destroys sprouting grain to a varying degree, but no other crops are seriously damaged. The young birds feed exclusively on insects, and experimentation on captive birds proves that nestlings consume very nearly their own weight of food daily.

The stomach examination indicates that about 03 per cent. of the total volume of food for the year consists of animal matter, of which a very large proportion consists of injurious insects, and nearly 73 per cent. of vegetable matter.

Mr. Bryant touches upon various other problems indirectly related to the problem in hand, and concludes that this species should be a protected non-game bird. The whole paper forms another valuable contribution to the literature on economic ornithology.

RELATION OF BIRDS TO GRAIN APHIDES.[2]—An outbreak of grain aphides in North Carolina led the writer to examine the stomach contents of a number of Goldfinch (*Astragalinus tristis*), Pine Siskin (*Spinus pinus*), Vesper Sparrow (*Pooecetes gramineus*), Savanna Sparrow (*Passerculus sandwichensis savanna*), Chipping Sparrow

[1] Bryant, H. C.—A Determination of the Economic Status of the Western Meadow-Lark (*Sturnella neglecta*) in California. Univ. of Calif. Publ. in Zool., 1914, vol. 11, pp. 377-510, pls. 21-24, and 5 text figs.

[2] McAtee, W. L.—Relation of Birds to Grain Aphides. Year-book U. S. Dept. Agric., 1912, pp. 395-404, 3 figs.

(*Spizella passerina*), Field Sparrow (*S. pusilla*), Snowbird (*Junco hyemalis*), Song Sparrow (*Melospiza melodia*), Titlark (*Anthus rubescens*). He concludes that upon about 100 acres of grainfields, from March 29th to April 4th, they destroyed about 1,000,000 grain aphides daily.

Fifty Common Birds on Farm and Orchard.[1]—The proprietors of the *National Geographic Magazine* have re-issued Mr. Henshaw's interesting paper, which was originally issued as Farmers' Bulletin 513 of the U.S. Department of Agriculture. In its present form it will no doubt appeal to a large number of readers, and serve to illustrate to the "man in the street" the magnificent work which the Bureau of the Biological Survey are doing. The fifty coloured figures are excellent.

The Protection of Birds in and around Ottawa.[2]—Dr. Gordon Hewitt here discusses the general question of the protection of birds and the reasons why this is necessary; the economic value of certain common birds which it is desirable to protect; and a proposal for the protection of the native birds around Ottawa.

In Ottawa it is proposed to regard two areas, Rockcliffe Park and the ground of the Botanical Garden of the Dominion Government's Experimental Farm, as bird sanctuaries in which steps will be taken, not only to prevent the destruction of the birds and the despoiling of their nests, but also to encourage their presence by providing those species which nest in holes and cavities with nesting boxes and sites. To this end the Ottawa Improvement Commission have agreed to provide and distribute 250 nest boxes in the former area, and the Director of the Experimental Farms has agreed to the distribution of 160 in the latter area.

Dr. Hewitt points out that the existence of two such bird sanctuaries will undoubtedly tend to prevent the gradual disappearance from the Ottawa district of a number of birds which are becoming less abundant than formerly. Further, it is reasonable to expect that when the northerly migrations are taking place in the spring, the encouragement offered will meet with a response, and birds which otherwise would have passed on will stay through the season. The scheme will afford the best check that can be adopted in preventing, as far as possible, the gradual departure of a number of native birds from this particular district.

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1 Henshaw, H. W.—Fifty Common Birds of Farm and Orchard. Nat. Geographic Mag., Washington, D.C., 1913, pp. 669-697, 50 coloured figs.

2 C. Gordon Hewitt.—The Protection of Birds in and around Ottawa. Ottawa Nat., 1914, vol. 27, pp. 161-171.

REVIEWS.

HANDBUCH DER PFLANZENKRANKHEITEN. By Dr. Paul Sorauer. Bd. III. Die tierischen Fiende. By Dr. L. Reh. Pp. xx + 774 and 306 text figures. Berlin: Paul Parey, 1913. Price £1 13s.

Professor Sorauer's *Handbuch* has long been regarded as the ablest exposition on the subject; wherever phytopathology is studied it has proved of the greatest assistance to both the investigator and student. Dr. Reh's treatment of the third volume fully sustains the high standard set in the previous ones. He has given us a treatise replete with information dealing with the whole of the animal kingdom in its economic aspect. The work is also of interest in affording an indication of the high level which economic biology has reached.

Anything like a complete outline of the life-histories of even typical examples was manifestly impossible in a work of this kind, but the terse manner in which it is written, the wealth of illustration, and the full bibliographic references make it one of the greatest value, and it must long remain the standard work upon the subject.

It is satisfactory to find ample recognition of the work that has been done in this country of recent years, indeed the author has taken considerable pains to make each section as complete as possible in the space at his disposal. The result is a treatise of enduring value, and worthy of the high reputation of its author.

A TEXTBOOK OF MEDICAL ENTOMOLOGY. By W. S. Paton and F. W. Cragg. Pp. xxxiv + 764 and 89 plts. London: Christian Literature Society for India, 1913. Price £1 1s. 0d.

To medical and veterinary officers and naturalists generally who are located in the tropics, this work will prove a real boon. As the authors state, the general plan of the work has been suggested by the difficulties with which they themselves have had to contend. Particular attention has been paid to the description of methods of breeding and laboratory manipulation, and there is a wealth of useful illustrations.

Briefly, the scope of the work is as follows:—After a general introduction, the second chapter is devoted to the anatomy and physiology of the blood-sucking Diptera, and forms an excellent introduction to insect morphology. The following three chapters deal with the general biology, classification, and life-history of numerous species of Diptera, with similar ones on the Rhynchota, Anoplura, Acarina, Pentastomida, and Eucopepoda.

There is a useful chapter on laboratory technique and an interesting one on the relation of Arthropoda to their parasites. Ample references are given to the literature at the end of each chapter, and there is a very full index.

The title of the book is not a good one, for a quarter of the work is devoted to Arthropoda other than insects.

The authors have taken infinite pains to produce a really useful work, and in spite of one or two shortcomings, they have succeeded, and at the same time materially added to our knowledge by a considerable amount of original investigation.

TRAITE D'ENTOMOLOGIE FORRESTIERE A L'USAGE DES FORESTIERS. Par A. Barbey. Pp. xiv + 624, 8 coloured plts. and 367 text figs. Paris: Berger-Levrault, 1913. Price 18 fr.

If for no other reason than the general excellence and wealth of illustration, this volume will be welcomed by all interested in forest entomology, but it has many other features to recommend it.

Commencing with a short introduction, in which the author reviews the historical side and gives a general account of insect anatomy and classification, we pass to the main body of the work. The author treats of the different classes of insects under the headings of the different trees, thus we have chapters on the Pines, Oaks, Chestnuts, Birches, Poplars, Limes, Elms, etc. The various insects are briefly but clearly described, and the damage they occasion indicated, with notes on preventive and remedial measures. In all cases there is a wealth of illustration, indeed, many of the figures are unsurpassed for detail and interest. They have been chosen with great care, and must prove of great value to foresters and entomologists alike.

The lucid and terse style in which the work is written should commend it to English readers, who will find much material of real practical value.

THE ELEMENTARY PRINCIPLES OF GENERAL BIOLOGY. By J. F. Abbott. Pp. xvi + 329 and 114 text figs. New York: The Macmillan Company, 1914. Price 6s. 6d. net.

The need of a concise treatise, such as the work before us, has long been felt by both teachers and students of Biology in this country. "In Biology," Professor Abbott states, "the field is so broad and so varied that the student is very likely to lose sight of the fundamental principles that underlie all living nature. Moreover, these principles do not grow out of the laboratory work so obviously as is the case with such sciences as chemistry and physics."

The book is well-planned, although in many cases condensed, nevertheless the ideas are clean-cut, definite, and well put, and there is an entire absence of vague notions so common in works of this kind.

Apart from the value of this book in the laboratory and classroom, we may regard its very publication as an indication of the thorough manner in which biology is taught and studied in the

American Universities, which leads us to inquire whether or not the too rigid adherence to "types" in this country is not starving the student of biology.

The present work is bound to grow (there is room for considerable amplification), and we trust its author will not rest satisfied until he has given us a really standard work built upon the present structure.

CONTROLLED NATURAL SELECTION AND VALUE MARKING. By J. C. Mottram. Pp. ix + 130. London: Longmans, Green & Co., 1914. Price 3s. 6d. net.

In this interesting little volume the author puts forth a new theory, or, as no attempt is made to prove it, he thinks it would have been better perhaps to have called it a new hypothesis. One of the chief reasons for advancing the Theory is to stimulate research, and also that it supports the Darwinian theory of the origin of species.

The theory is stated under four headings, viz.: (1) Natural Selection appreciates the differences in character which distinguishes male from female, young and old. (2) Natural Selection must treat associations of individuals as units, just as it does single individuals. (3) Natural Selection, just as it brings about diversity of structure by acting on individuals, so it must bring about diversity of structure by acting upon associations of individuals. (4) These diversities of structure found in the unequally valuable number of societies, control Natural Selection in such a way that the less valuable are more liable to destruction than the more valuable.

Whatever value one attaches to the author's views no one will question the interest of the work. Many of the chapters might be considerably amplified, and no doubt will be in future editions. The book is certain to command a wide circle of readers.

PHYSIOLOGICAL PLANT ANATOMY. By Dr. G. Haberlandt. Translated from the Fourth German edition by Montagu Drummond. Pp. xv + 777 and 291 figs. London: Macmillan & Co., Ltd., 1914. Price 25s. net.

Professor Haberlandt's *Physiologische Pflanzenanatomie* is deservedly well-known to most botanical students, and the appearance of an English translation will serve to increase the number who may benefit by a study of its pages.

It was in 1881 that the author first put forward his physiological classifications of tissue-systems, which in 1884 were embodied in the first edition of the present work. The present translation is of the fourth German edition.

We believe this to be the only thorough and exhaustive account of the connection between the structure and the functions of the tissue-systems, and it contains a mine of information, methodically described. There are many views advanced which are still debateable, but with these we are not here concerned. We welcome the work, with its wealth of notes and full indices, as a distinct gain to botanical literature, and one which undoubtedly will be largely made use of by English students.

SOME MINUTE ANIMAL PARASITES. By H. B. Fantham and Annie Porter. Pp. xi + 319, 1 plt and 56 figs. London: Methuen & Co., Ltd., 1914. Price 5s. net.

The recent rapid advances in protozoology have resulted in a very voluminous literature upon the subject, which it is quite impossible for the layman or even the science student to follow; the need therefore for a scientific but readable account of the various unicellular parasites that are the cause of disease in man and his domestic animals is apparent.

In the work before us the authors have given us a most interesting account of these different minute parasites and the diseases they give rise to, but we are surprised to find that no references are given to the original sources from which the information has been obtained. To the student a short bibliography at the end of each chapter would have proved exceedingly useful. This is undoubtedly a serious defect in an otherwise really useful little work.

A COURSE OF PRACTICAL WORK IN THE CHEMISTRY OF THE GARDEN. By D. R. Edwardes-Ker. Pp. 40. London: John Murray, 1914. Price 1s. 6d. net.

There must be many teachers in agricultural schools, or where agriculture is taught, who desire such a little text-book as this, and we can strongly recommend it to their notice. The four chapters deal with the chemistry of plants, soils, manures and fertilisers, and sprays and washes; all are thoroughly practical, and in the hands of a capable teacher could not fail to prove highly instructive and valuable.